

viduals are recognised to be functions of each other, at death they are supposed to shrivel into isolated and alien units."

The only future that is possible is an immortality of function. An organism is nothing but a centre or focus through which the world-energy operates. When the organism is lost in what we call death, the function may well enough go on in terms of more subtle forms of energetic activity (*cf.* Prof. James's little book, "Human Immortality").

Perhaps, if a criticism may be ventured, modern "psychology-without-a-soul" has become *too much* afraid of being metaphysical. A function must be a function of something. If there is an act, there must be an actor who is, in a way, greater and more real than the act. A soul-entity, then, is justified. It is as reasonable to posit it as to posit a surviving "function."

But the volume is full of deep and careful thinking, and is suggestive and stimulating even in its more questionable doctrines. The analysis of consciousness, and the chapters on the test of truth and on mind and matter, are particularly good.

SOME GERMAN MATHEMATICAL TREATISES.

- (1) *Einführung in die Vektoranalysis, mit Anwendungen auf die mathematische Physik.* By Prof. Richard Gans. Zweite Auflage. Pp. x+126. (Leipzig: B. G. Teubner, 1909.) Price 3.60 marks.
- (2) *Die Vektoranalysis und ihre Anwendung in der theoretischen Physik.* By Dr. W. v. Ignatowsky. Teil I. Die Vektoranalysis, pp. vii+112. Teil II. Anwendung der Vektoranalysis in der theoretischen Physik. Pp. iv+123. (Leipzig: B. G. Teubner, 1909-10.) Price 6 marks.
- (3) *Vorlesungen zur Einführung in die Mechanik raumerfüllender Massen.* By Prof. Alexander Brill. Pp. x+236. (Leipzig: B. G. Teubner, 1909.) Price 8 marks.
- (4) *Funktionentafeln mit Formeln und Kurven.* By Prof. Eugen Jahnke and Fritz Emde. Pp. xii+176. (Leipzig: B. G. Teubner, 1909.) Price 6 marks.
- (5) *Die Zentrifugalkraft.* By Prof. Friedrich Poske. Pp. 80. (Berlin: Julius Springer, 1909.) Price 3 marks.
- (6) *Interpolationsrechnung.* By Prof. T. N. Thiele. Pp. xiii+173. (Leipzig: B. G. Teubner, 1909.) Price 10 marks.

(1) THE simplified system of vector analysis promoted by Gibbs and Heaviside has met with such general acceptance in Germany that treatises and memoirs on subjects of mathematical physics are now often hardly intelligible to readers who do not possess some familiarity with the notations and processes of the calculus in question. A demand has thus arisen for elementary expositions limited to what is absolutely necessary for physical purposes. The first book on our list, now in its second edition, is written mainly with a view to the electrical applications. It deals in a clear and simple fashion with the fundamental operations, and then passes on to the discussion of vector-fields. An interesting chapter on "tensors," which have a bearing on the theories

of stress and of quadratic moments, is added. The work closes with a few elementary applications to hydrodynamics and electromagnetism. It may be commended as giving in a very brief compass almost all that is of importance to the physical student.

(2) This work consists of two parts. In the first of these vector analysis is developed from its foundations as an independent discipline, without any reference to Cartesian or other special geometrical coordinates. The author claims some degree of novelty for his methods of exposition, we think with justice. In particular the intrinsic nature of Hamilton's operator ∇ , whether as applied to a scalar quantity, or by scalar multiplication to a vector, or by vector multiplication to a vector, is here explained with great insight and (we believe) originality. The passages in question may be recommended to the notice of those who have felt the inadequacy of the usual Cartesian treatment of the matter. The theorems of Green and Gauss naturally present themselves for discussion, and, as in the preceding work, a chapter is added on tensors. The second volume contains a number of applications to elasticity, hydrodynamics, electricity, and crystalline reflection.

(3) This is a course of lectures on the dynamics of continuous systems, written from a special point of view. The inspiration is derived from Hertz, but the author prefers to employ Gauss's principle of least constraint rather than the Hertzian law of the "straightest path." The treatment is somewhat academic, in the sense that stress is laid on unity of method rather than on the specific interest of the various topics discussed, but it is marked by clearness and great mathematical elegance. The subjects considered include the kinetics of rigid bodies and of fluid and elastic media, and, finally, the electromagnetic theory of light. On one point a protest should, in the opinion of the present writer, be entered. The notion that the apparent potential energy of a dynamical system may be accounted for as the kinetic energy of latent internal motions is here, as in many recent Continental writings, attributed too absolutely to Hertz. If nowhere stated so explicitly, perhaps, it must have been present to the mind, not only of Lord Kelvin, but of all students of his various expositions of the theory of gyrostatic systems, to say nothing of the well-known "kinetic theory" of elasticity.

(4) This is intended as a supplement to the ordinary tables of mathematical functions. Of recent years a great deal of work has been done, especially in this country, in tabulating the functions which occur in various important problems of mathematical physics, but the results are scattered in the proceedings of societies and in scientific journals, and are often unavailable, and even unknown, to those who have most need of them. The authors of the present treatise have collected a number of such tables, and have appended explanations of the notations, and lists of the important formulæ. The whole is brought within a moderate compass by restricting the entries to four significant figures; this is, of course, ample for most physical purposes, and more than sufficient for graphical representation. We are

glad to note that the author pays a tribute to the British Association Committee on Mathematical Tables, the activity of which has, unfortunately, in recent times somewhat slackened. The collection includes tables of the sine-integral, cosine-integral, and exponential-integral, the Fresnel transcendents, the gamma-function, the error-function, elliptic integrals, spherical harmonics, and the Bessel's functions of both kinds. Especially welcome are the tables of the latter function in which the argument is complex.

Every worker in applied mathematics will applaud this publication, and will wish it such success that it may be speedily followed by new and still more comprehensive editions.

(5) A "philosophical" discussion of the nature of centrifugal force is hardly suited for review in these pages. Such discussions are apt to resolve themselves into verbal questions, and we fear that the present one is no exception. The author insists, for example, on a distinction between "motive forces" and "resistances," the tension of a string being reckoned as belonging to the former category, the pressure of a smooth surface to the latter! The tract is lengthy and diffuse.

(6) A formal treatise on the theory of interpolation from the former professor of astronomy at Copenhagen is sure of respect. The present work is carefully written, and apparently from an independent standpoint. There is, indeed, hardly any explicit reference to the work of previous writers other than Newton and Lagrange, and novel notations are introduced freely without any reference to accepted forms which have long been in general use. The author claims for the subject an important place in schemes of mathematical instruction. To this we can hardly assent; processes of interpolation are, of course, constantly required, in one form or another, but a systematic study of the subject as an independent discipline would, in the case of most students, be an unnecessary infliction. The case of those who are training to become experts in certain special subjects is, of course, different.

H. L.

OUR BOOK SHELF.

An Introduction to Petrology. By F. P. Mennell. Second edition. Pp. viii+204. (London: Gerrards, Limited, 1910.) Price 8s. net.

This is a plain and clearly written introduction to a branch of geology that has assumed much importance among students, and it has the merit of including a short description of the minerals that go to make up rocks. The author's personal studies, as is well known, have been carried on mainly in Rhodesia, and there is something pleasant in finding familiar facts illustrated from Bulawayo, Kimberley, or the Rand. The palisade structure of basaltic flows is thus well seen in the view of the Zambezi gorge on p. 92. In addition, we gain by the introduction of the results of tropical weathering on rocks; and the remarkable banded siliceous ironstones of South Africa (p. 180) are referred to the concentration of mineral matter in a stratified series near the surface.

Theoretical questions are touched on sufficiently to arouse interest, and a sane balance seems to be preserved between what can be seen in the field and what may be variously inferred. The discussion of

the absorption of schists and sediments by the granite of the Matopos and Mashonaland is sustained by evidence that seems convincing, and it has been our good fortune to go over something of this ground in the company of the author. The arguments derived from the amphibolites (p. 171) might have been supported by work of earlier date than that quoted, such as that done in Saxony and round Mont Blanc; but the introduction of matter of this kind, of chapter xiii. (on the origin and variations of igneous rocks), and of the well-reasoned chapter xix., on metamorphism, show that the author regards petrology as far more than the mere description of rock-specimens. Enough is said on each point to show what researches lie before the worker in the open country.

Simple and descriptive as the book is, it will undoubtedly encourage thought in all who read it. The illustrations are excellent, though we should like fewer rock-sections, and more landscapes, such as that on p. 101. Very few misprints—"Brux" for "Brux," "Fougué" for "Fouqué," and "entectic" for "eutectic," twice on p. 89—have been noted. The formulæ of the silicates might be modernised in the next edition, since comparison is thus rendered more easy. On p. 70 the resemblance between kaolin and serpentine is unnecessarily obscured by a small difference of method. A comma is wanted in the dolomite formula on p. 75; but is not this better written $MgCa(CO_3)_2$? The change of appearance in a section of calcite when the polariser is rotated beneath it (p. 75) is due to differences in "relief" at the surfaces, and not to differences of absorption within the section. This well-printed book, as a whole, is a very pleasant one to read.

G. A. J. C.

Map of Eastern Turkey-in-Asia, Syria, and West Persia. Scale, 1/2,000,000, or 1 inch=31.56 miles. (London: Royal Geographical Society, 1910.)

THE issue of this map occurs at an opportune moment. Public attention has been much directed lately to the once fertile strip of country that lies between the deserts of Arabia on the one hand, and the mountains of Asia Minor on the other. It is needless to dwell here on the visions of the past that a mere inspection of the names on this map will call up in the mind of the historian. Looking to the future alone, it is obvious that we have before us the representation of a piece of country destined once again to play an important part in human history, and to be the scene of a busy commerce and a thriving agriculture. Whatever be the political difficulties now blocking the way, it is certain that before very long we shall see the construction of the railway joining the Mediterranean with the head of the Persian Gulf, a route possibly extending through southern Persia and Baluchistan to India itself. In the more immediate future we shall see the rich land that lies between and about the great twin rivers wake from its sleep of four centuries and water again flow through canals and irrigation channels long choked with the desert sands.

The report on the irrigation system recently published by Sir W. Willcocks makes it clear that, with no great engineering difficulties, and even with no great expenditure of capital, some, at all events, of the old irrigation works can be reopened and a large area of land once more taken into cultivation. The enterprise and energy with which this work is now actually being taken up is the best evidence of the change that has come over the spirit of Turkish administration since the advent of constitutional government.

It is sincerely to be hoped that the prime importance of carrying out an accurate survey in advance of agricultural development will not be lost sight of. In